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# Report of the United Nations Scientific Committee on the Effects of Atomic Radiation

## Sixty-fourth session
## (29 May-2 June 2017)

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# Report of the United Nations Scientific Committee on the Effects of Atomic Radiation

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*Note*

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# Contents


| *Chapter* | | *Page* |
|---|---|---|
| I. | Introduction | 1 |
| II. | Deliberations of the United Nations Scientific Committee on the Effects of Atomic Radiation at its sixty-fourth session | 2 |
| | A. Completed evaluations | 2 |
| | B. Present programme of work | 3 |
| | 1. Developments since the 2013 report on the levels and effects of radiation exposure due to the nuclear accident following the great east-Japan earthquake and tsunami: review of 2016 scientific literature | 3 |
| | 2. Selected evaluations of health effects and of risk inference due to radiation exposure | 4 |
| | 3. Lung cancer from exposure to radon and to penetrating radiation | 4 |
| | 4. Biological mechanisms influencing health effects from low-dose radiation exposure | 5 |
| | 5. Assessments of human exposure to ionizing radiation | 5 |
| | 6. Implementation of the Committee's strategy on public information and outreach strategy | 7 |
| | C. Implementation of the Committee's long-term strategic directions | 8 |
| | D. Future programme of work | 9 |
| | E. Administrative issues | 9 |
| III. | Scientific report | 11 |
| | A. Principles and criteria for ensuring the quality of the Committee's reviews of epidemiological studies of radiation exposure | 11 |
| | B. Epidemiological studies of cancer risk due to low-dose-rate radiation from environmental sources | 11 |
| Appendices | | |
| I. | Members of national delegations attending the sixty-second to sixty-fourth sessions of the United Nations Scientific Committee on the Effects of Atomic Radiation | 13 |
| II. | Scientific staff and consultants cooperating with the United Nations Scientific Committee on the Effects of Atomic Radiation in the preparation of its scientific report for 2017 | 15 |

# Chapter I

## Introduction

1. Since the establishment of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) by the General Assembly in its resolution 913 (X) of 3 December 1955, the mandate of the Committee has been to undertake broad assessments of the sources of ionizing radiation and its effects on human health and the environment.[1] In pursuit of its mandate, the Committee thoroughly reviews and evaluates global and regional exposures to radiation. The Committee also evaluates evidence of radiation-induced health effects in exposed groups and advances in the understanding of the biological mechanisms by which radiation-induced effects on human health or on non-human biota can occur. Those assessments provide the scientific foundation used, inter alia, by the relevant agencies of the United Nations system in formulating international standards for the protection of the general public, patients and workers against ionizing radiation;[2] those standards, in turn, are linked to important legal and regulatory instruments.

2. Exposure to ionizing radiation arises from naturally occurring sources (such as radiation from outer space and radon gas emanating from rocks in the Earth) and from sources with an artificial origin (such as medical diagnostic and therapeutic procedures; radioactive material resulting from nuclear weapons testing; energy generation, including by means of nuclear power; unplanned events such as the nuclear power plant accident at Chernobyl in 1986 and that following the great east-Japan earthquake and tsunami of March 2011; and workplaces where there may be increased exposure to artificial or naturally occurring sources of radiation).

[1] The United Nations Scientific Committee on the Effects of Atomic Radiation was established by the General Assembly at its tenth session, in 1955. Its terms of reference are set out in resolution 913 (X). The Committee was originally composed of the following Member States: Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia (later succeeded by Slovakia), Egypt, France, India, Japan, Mexico, Sweden, Union of Soviet Socialist Republics (later succeeded by the Russian Federation), United Kingdom of Great Britain and Northern Ireland and United States of America. The membership of the Committee was subsequently enlarged by the Assembly in its resolution 3154 C (XXVIII) of 14 December 1973 to include the Federal Republic of Germany (later succeeded by Germany), Indonesia, Peru, Poland and the Sudan. By its resolution 41/62 B of 3 December 1986, the Assembly increased the membership of the Committee to a maximum of 21 members and invited China to become a member. In its resolution 66/70 of 9 December 2011, the Assembly further enlarged the membership of the Committee to 27 and invited Belarus, Finland, Pakistan, the Republic of Korea, Spain and Ukraine to become members.

[2] For example, the international basic safety standards for radiation protection and safety of radiation sources, currently co-sponsored by the European Commission, the Food and Agriculture Organization of the United Nations, the International Atomic Energy Agency (IAEA), the International Labour Organization, the Nuclear Energy Agency of the Organization for Economic Cooperation and Development, the Pan American Health Organization, the United Nations Environment Programme and the World Health Organization.

# Chapter II

## Deliberations of the United Nations Scientific Committee on the Effects of Atomic Radiation at its sixty-fourth session

3. The Committee held its sixty-fourth session in Vienna from 29 May to 2 June 2017.[3] The following served as officers of the Committee: Hans Vanmarcke (Belgium) as Chair; Patsy Thompson (Canada), Peter Jacob (Germany) and Michael Waligórski (Poland) as Vice-Chairs; and Gillian Hirth (Australia) as Rapporteur.

4. The Committee took note of General Assembly resolution 71/89 on the effects of atomic radiation, in which the Assembly requested the Committee to report to the Assembly at its seventy-second session on its important activities to increase knowledge of the levels, effects and risks of ionizing radiation from all sources.

### A. Completed evaluations

5. At its sixty-third session, the Committee had discussed progress on an evaluation of epidemiological studies of cancer incidence from low-dose-rate exposures due to environmental sources of radiation. It had welcomed the development of an appendix on quality criteria for the Committee's reviews of epidemiological studies, and requested that the scientific review and the quality criteria be brought into accordance with each other. It also had requested that the appendix be finalized for publication as an independent annex because of its wider application. In addition, it had also requested the secretariat to prepare a short paper on the scientific view of the Committee on the dose and dose rate effectiveness factor.

6. The Committee discussed in detail the two revised scientific annexes to the present report (see ch. III below) and the short paper (see para 5 above), agreed on the scientific report of their findings, and decided that the annex on the evaluation of epidemiological studies of cancer incidence from low-dose-rate exposures should incorporate relevant material from the paper. It requested that the two annexes then be published in the usual manner, subject to modifications agreed upon.

7. At its sixty-third session, the Committee had also requested the secretariat to prepare an evaluation of data on thyroid cancer in regions affected by the Chernobyl accident. The Committee discussed a paper that recapitulated the Committee's previous findings on this matter, reported the latest data provided by the three most affected countries (Belarus, Russian Federation and Ukraine), summarized key literature of the past several years, and made an assessment of the fraction of the observed thyroid cancer incidence that could be deemed attributable to radiation exposure of the thyroid:

(a) Both the total number of cases and crude incidence rate (number of cases per 100,000 person-years) basically increased monotonically over the period 2006-2015. The total number of cases of thyroid cancer registered in the period 1991-2015 in males and females who were under 18 in 1986 (for the whole of Belarus and Ukraine, and for the four most contaminated oblasts of the Russian Federation) approached 20,000. This number is almost three times higher than the number of thyroid cancer cases registered in the same cohort in the period 1991-2005;[4]

(b) However, the observed increase in the incidence of thyroid cancer is not all attributable to radiation exposure. It is influenced by various factors: increased

[3] The sixty-fourth session was also attended by observers for IAEA, the International Agency for Research on Cancer, the European Union, the International Commission on Radiological Protection and the International Commission on Radiation Units and Measurements.

[4] *Sources and Effects of Ionizing Radiation: United Nations Scientific Committee on the Effects of Atomic Radiation 2008 Report to the General Assembly*, vol. II, annex D (United Nations publication, Sales No. E.11.IX.3).

spontaneous incidence rate with adulthood, radiation effect, and improvement of diagnostic methods. Discerning the effect of exposure to ionizing radiation contributing to this complicated situation requires both careful epidemiological analysis and basic research of processes in molecular biology;

(c) The Committee estimated that the fraction of the incidence of thyroid cancer attributable to radiation exposure among non-evacuated residents of Belarus, Ukraine and the four most contaminated oblasts of the Russian Federation who were children or adolescents at the time of the accident, is of the order of 0.25. The uncertainty in the estimated attributable fraction ranges at least from 0.07 to 0.5.

8. The Committee requested that the evaluation of thyroid cancer data in regions affected by the Chernobyl accident be issued electronically on its website as a non-sales publication in English, subject to modifications agreed upon.

## B. Present programme of work

### 1. Developments since the 2013 report on the levels and effects of radiation exposure due to the nuclear accident following the great east-Japan earthquake and tsunami: review of 2016 scientific literature

9. The Committee recalled its assessment of the exposures and effects due to the nuclear accident after the 2011 great east-Japan earthquake and tsunami, as presented in its report to the sixty-eighth General Assembly in 2013[5] and the supporting detailed scientific annex.[6] It had concluded in that report that, in general, doses were low and that therefore associated risks were also expected to be low. A discernible increase in cancer incidence in the adult population of Fukushima Prefecture that could be attributed to radiation exposure from the accident was not expected. Nevertheless, the report noted a possibility that an increased risk of thyroid cancer among those children most exposed to radiation could be theoretically inferred, although the occurrence of a large number of radiation-induced thyroid cancers in Fukushima Prefecture — such as occurred after the Chernobyl accident — could be discounted because absorbed doses to the thyroid after the accident at Fukushima were substantially lower. It had also concluded that no discernible changes in birth defects and hereditary diseases were expected and that any increased incidence of cancer among workers due to their exposure was expected to be indiscernible because of the difficulty of confirming a small increase against the normal statistical fluctuations in cancer incidence. The effects on terrestrial and marine ecosystems were expected to have been transient and localized.

10. Following its assessment, the Committee put in place arrangements for follow-up activities to enable it to remain abreast of additional relevant information as it was published. The Committee's reports of the sixty-second and sixty-third sessions to the seventieth and seventy-first sessions of the General Assembly, respectively, included the Committee's findings from its follow-up activities up to the relevant time in each case.

11. The Committee has continued to identify further information that had become available up to the end of 2016, and systematically appraised relevant new publications to assess their implications for the Committee's 2013 report. A large proportion of these new publications have again confirmed the main assumptions and findings of the Committee's 2013 report. None of the publications have materially affected the main findings in, or challenged the major assumptions of, the Committee's 2013 report. A few have been identified for which further analysis or more conclusive evidence from additional research is needed. On the basis of the

[5] *Official Records of the General Assembly, Sixty-eighth session, Supplement No. 46* and corrigendum (A/68/46 and Corr.1)

[6] *Sources, Effects and Risks of Ionizing Radiation: United Nations Scientific Committee on the Effects of Atomic Radiation 2013 Report to the General Assembly*, vol. I, annex A (United Nations publication, Sales No. E.14.IX.1)

material reviewed, the Committee sees no need, at the current time, to make any change to its assessment or its conclusions. However, several of the research needs identified by the Committee have yet to be addressed fully by the scientific community.

12. The Committee has requested that the findings be issued electronically on its website as a non-sales publication in English and that, subject to available resources, its publication be fostered in Japanese.

### 2. Selected evaluations of health effects and of risk inference due to radiation exposure

13. The UNSCEAR 2012 report, annex B, entitled "Uncertainties in risk estimates for radiation-induced cancer", summarized the current methodologies to estimate health risks from exposure to ionizing radiation including their uncertainties.[7] A key outcome was the need to go beyond purely statistical uncertainties and take into account other sources of uncertainty, for example those due to dose estimates or the model chosen for analysing epidemiological data.

14. At its sixty-second session, the Committee agreed to start work on evaluations of selected health effects and the inference of risk. Five scenarios have been developed for risk evaluation, based on literature reviews: leukaemia after medical computed tomography scans during childhood or adolescence; leukaemia after occupational exposure; solid cancer risk after acute and protracted exposure; thyroid cancer risk after exposure during childhood or adolescence; and risk of circulatory diseases after acute and protracted exposure. In the draft presented by the expert group the authors considered some of the uncertainties involved in the estimation of health effects and of risk inference. The Committee noted that it needed more time to fully express and analyse these and other uncertainties for each scenario, as well as to ensure that the process was in line with the newly completed annex on principles and criteria for ensuring the quality of the Committee's reviews of epidemiological studies of radiation exposure (see section III.A below). It expected to discuss a draft scientific annex addressing these issues at its sixty-fifth session.

### 3. Lung cancer from exposure to radon and to penetrating radiation

15. The Committee considered the effects of exposure to radon (and thoron) in homes and workplaces in 2006,[8] when it concluded that inhalation of radon and its decay products was carcinogenic mainly for the lungs. Since that last comprehensive evaluation there have been many scientific publications concerning radiation exposure and lung cancer, including those related to epidemiological studies of lung cancer in exposed populations from both internal exposure to radon and external exposure to penetrating radiation (typically gamma), as well as many relevant publications on dosimetry.

16. At its sixty-third session, held from 27 June to 1 July 2016, the Committee agreed to thoroughly assess the recent literature with a view to clarifying and assessing recent developments in risk estimates for lung cancer from exposure to radon and thoron compared to the lung cancer risk from external exposure to penetrating radiation, and to convey an up-to-date picture of radon dosimetry.

17. An expert group has started a systematic review of the literature and the Committee envisages that a draft scientific annex can be discussed at its sixty-fifth session, thereby allowing the Committee to consider how it would assign dose values for its own evaluations of exposure to radon.

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[7] *Sources, Effects and Risks of Ionizing Radiation: United Nations Scientific Committee on the Effects of Atomic Radiation 2012 Report to the General Assembly*, annex B (United Nations publication, Sales No. E.16.IX.1).

[8] *Effects of Ionizing Radiation: United Nations Scientific Committee on the Effects of Atomic Radiation 2006 Report to the General Assembly*, vol. II, annex E (United Nations publication, Sales No. E.09.IX.5).

### 4. Biological mechanisms influencing health effects from low-dose radiation exposure

18. At its sixty-third session, the Committee decided to develop an up-to-date picture of the current knowledge on biological mechanisms of radiation actions relevant to disease development, particularly at low incremental doses and dose rates, their implications for the dose-response relationship for health effects at low doses, and thus their relevance for estimation of associated risks to health.

19. The specific objective will be to address the following questions: (a) for which biological mechanisms is there evidence that indicates they can affect the frequency of health effects following exposure to ionizing radiation, including at low doses and dose rates? What are the differences in utilization and/or activation of those pathways and mechanisms at low doses compared with moderate doses? What dose-response relationships are available as evidence for these mechanisms? (b) considering such mechanisms, can any conclusions be drawn as to their overall influence on the dose-response relationship between health effects of radiation exposure at low doses compared with moderate doses? (c) are there ways to link information on the biological processes and mechanisms found to be relevant to human health effects to existing epidemiological data on incidence of disease in exposed populations? (d) is there evidence for tissue-specific variation in the mechanisms of response to ionizing radiation that relate to the differing sensitivity of tissues to radiogenic cancer? (e) are the mechanisms that operate similar for low- and high-linear-energy-transfer exposures?

20. An important aspect of this work is to constrain the range of biological endpoints and/or phenomena under consideration to those that are known or reasonably expected to play a role in radiogenic disease. The Committee decided that work should be focused on carcinogenesis.

21. For the coming year, the Committee expects that formal literature searches will be conducted for publications relevant to addressing each detailed objective and identified subsidiary issues. Moreover, it expects to review at its sixty-fifth session a draft document that will focus on reporting what has changed significantly since 2006 that might be relevant for the dose-response at low doses.

### 5. Assessments of human exposure to ionizing radiation

22. The Committee took note of a progress report by the secretariat on the collection, analysis and dissemination of data on radiation exposures of the public, patients and workers. The Committee welcomed the fact that the General Assembly, in its resolution 71/89, had encouraged Member States to nominate a national contact person to facilitate coordination of the collection and submission of data on human exposure. However, as of May 2017, only 60 countries had nominated national contact persons, 27 countries had submitted data for the UNSCEAR Global Survey on Medical Exposure and 3 countries for the UNSCEAR Global Survey of Occupational Radiation Exposures. The Committee requested the secretariat to once again request States Members of the United Nations to nominate national contact persons to coordinate data collection at the national level, and extended its deadline for submission of data until June 2018.

#### (a) Exposures of the public to ionizing radiation

23. Exposures from natural sources constitute the largest component of human exposure, though they remain relatively stable over time, in contrast to artificial sources of patient, occupational and public exposure. Exposures of the public from artificial sources in the environment are usually the smallest component (excluding accidents), and yet they are of considerable interest to Governments and civil society. The most significant database in this regard is the Database on Discharges of Radionuclides to the Atmosphere and the Aquatic Environment (DIRATA), developed by the International Atomic Energy Agency (IAEA). It centralizes official records on radioactive discharges to the terrestrial and aquatic environment worldwide. DIRATA

includes data on atmospheric and aquatic discharges of radionuclides from nuclear and non-nuclear facilities where available and has interfaces for the entry, editing, interrogation and reporting of data. With regard to any future UNSCEAR assessment of public exposure from such discharges, the Committee noted that the secretariat has held preliminary discussions with IAEA to explore the best methods to update and use the relevant datasets.

### (b) Exposures of patients to ionizing radiation

24. Given that radiation exposures of patients worldwide are the main artificial source of human exposure to ionizing radiation, that there is a continuing upward trend in population doses, and that the pace of technological development in this field continues to accelerate, the Committee's regular evaluations of population doses and trends continue to be important. The scope of the Committee's past evaluations has included assessing the annual frequency of procedures undertaken and the evaluation of radiation doses for each type of procedure. There are four general categories of medical practice involving exposure to ionizing radiation: diagnostic radiology, image-guided interventional radiology, nuclear medicine and radiation therapy. Doses from radiation therapy have not been included in the global estimates of population doses, but have been considered in trend analyses.

25. The Committee's evaluation relies on data submitted by Member States, supplemented by information published in the scientific literature. Since 2010, when the Committee agreed on a long-term strategy for improving data collection, analysis and dissemination, the following steps have been taken: (a) the questionnaires for the UNSCEAR Global Survey of Medical Exposure have been revised; (b) collaboration with international and intergovernmental organizations has been enhanced, including arrangements with the World Health Organization and the European Union; (c) an online platform has been developed for data collection; (d) a network of national contact persons has been instituted; and (e) an expert group has been established to prepare the evaluation of literature and data using a standard methodology.

26. The General Assembly had previously encouraged Member States to submit data. However, as of May 2017, only 27 countries had submitted data concerning diagnostic and interventional radiology, 25 countries for nuclear medicine and 22 countries for radiotherapy. All submissions currently available related to countries with high levels of health care, yet the quality of the data submitted was quite variable and were insufficient to allow any worthwhile assessment of global practice. Thus, the Committee decided to extend data collection until June 2018 and to circulate a simplified questionnaire requesting information on the total number of diagnostic radiology examinations (including and excluding dental examinations), interventional radiological procedures, and the total numbers of nuclear medicine procedures and radiotherapy treatments. The aim of this very much simplified approach was to obtain more submissions from countries with lower health-care levels, as such submissions were needed for a valid assessment of global practice.

27. The expert group on patient exposure has started the systematic review of more than 250 relevant new publications identified by literature search since the Committee's last evaluation of medical exposure, in 2005. Moreover, it has reviewed and developed the model for assessing population exposures based on data collected in the survey, as well as an approach to quantifying uncertainties. However, it is clear that literature dealing with medical exposure in Africa, Asia and Latin America is limited. The Committee recommends encouraging States Members of the United Nations to submit relevant national reports or evaluations to the secretariat, ideally including a short summary of the publication in English or another official language of the United Nations.

### (c) Exposures of workers to ionizing radiation

28. The Committee conducts evaluations of the worldwide occupational exposure to provide information relevant for policy and decisions regarding the use and

management of radiation, in particular: (a) to provide a reliable and comprehensive estimate of worldwide dose distributions and trends so that they may be placed in context; (b) to provide insight into the main sources of exposure, the most significant exposure situations and the main factors influencing dose distributions and trends, reflecting as appropriate high-level concerns of the United Nations such as those related to environment, security, human rights and gender issues; (c) to facilitate the evaluation of the impact of new techniques or technologies, of regulatory changes and of risk management programmes; (d) to identify emerging issues and opportunities for improvement that may warrant more attention and scrutiny; (e) to provide authoritative information that can be used for communicating, formulating or underpinning policy and decisions, and for investigative work; and (f) to provide insight into the reliability of the evaluations and identify areas for future research.

29. The Committee has conducted its evaluations of worldwide occupational exposure and trends based on two sources: (a) data from the UNSCEAR Global Survey of Occupational Radiation Exposures; and (b) reviews of analyses conducted and published by others. With respect to the first source the secretariat has developed an online platform for data submission and in August 2016 launched a survey.[5]

30. Since 2010, when the Committee agreed on a long-term strategy for improving data collection, analysis and dissemination, the following steps have been taken: (a) the questionnaires for the UNSCEAR Global Survey of Radiation Occupational Exposures have been revised; (b) collaboration with international and intergovernmental organizations has been enhanced, including arrangements with IAEA and the International Labour Organization; (c) an online platform has been developed for data collection; (d) a network of national contact persons has been instituted; and (e) an expert group has been established to prepare the evaluation of literature and data using a standard methodology. In the same way as with data on medical exposure, the Committee has decided to extend data collection until June 2018.

31. The expert group on occupational exposure has also started the systematic review of more than 450 relevant new publications identified by literature search since the Committee's last evaluation of occupational exposure, in 2002. Moreover it has reviewed and developed the model for assessing population exposures based on data collected in the survey, as well as an approach to quantifying uncertainties. As was the case for the assessment of patient exposure, it is clear that literature dealing with occupational exposure in Africa, Asia and Latin America is limited. The Committee recommended encouraging States Members of the United Nations to submit relevant national reports or evaluations to the secretariat, ideally including a short summary of the publication in English or another official language of the United Nations.

## 6. Implementation of the Committee's strategy on public information and outreach strategy

32. The Committee took note of a progress report by the secretariat on outreach activities, and acknowledged in particular the work done in Japan to disseminate the Committee's 2013 report on the levels and effects of radiation exposure due to the accident at the Fukushima Daiichi nuclear power station,[6] and the subsequent white papers of 2015 and 2016 on developments since that report. The progress included outreach events in Fukushima Prefecture and preparation and dissemination of information material in Japanese. The Committee noted that while the General Assembly had encouraged the secretariat to continue to disseminate the findings to the public, and that activities conducted by the secretariat had had a demonstrable impact in that regard, this and other outreach activities would henceforth have to be curtailed because of a lack of personnel in the secretariat and associated financial resources. The Committee also welcomed the online publication by the United Nations Environment Programme (UNEP) of the updated booklet entitled "Radiation:

[5] Available at http://www.survey.unscear.org.

effects and sources". The booklet was intended as a guide for the public and appeared in the official languages of the United Nations. Further efforts were being made to make it available in other languages as well. The Committee noted with appreciation the timely launch of the UNSCEAR 2016 report,[10] the secretariat's outreach efforts to engage with other audiences such as the diplomatic community in Vienna, academia, students and tour groups visiting the Vienna International Centre, and the use of other media such as United Nations Radio and social media, to further raise awareness of the Committee and its work. It also noted that the UNSCEAR homepage[11] had been updated to indicate that the Committee's work was relevant to achieving the Sustainable Development Goals.[12]

## C. Implementation of the Committee's long-term strategic directions

33. The Committee recalled that at its sixty-third session it had considered its long-term strategic directions beyond the period covered by its present strategic plan (2014-2019), and had envisaged to direct its future work in specific scientific areas. It also recalled the possible need to implement a range of strategies that would support its efforts to serve the scientific community as well as wider audiences. It was foreseen that these strategies would include:

(a) Establishing standing working groups focused on areas such as sources and exposure, or health and environmental effects;

(b) Inviting, on an ad hoc basis, scientists from other States Members of the United Nations to participate in evaluations regarding the above areas;

(c) Increasing the Committee's efforts to present its evaluations, and summaries thereof, in a manner that attracts readers without compromising scientific rigour and integrity;

(d) While maintaining its lead in providing authoritative scientific evaluations to the General Assembly, liaising closely with other relevant international bodies to avoid duplication of efforts to the extent possible.

34. The Committee also recalled that, in its resolution 71/89, the General Assembly had encouraged the Committee, over its coming sessions, to work towards implementing such strategies.

35. Although it recognized that these strategies were intended for beyond 2019, the Committee nevertheless began preliminary discussions on concepts of operations for standing working groups in two areas — exposures and effects — to scrutinize technical work and to monitor scientific developments in those areas. The Committee requested the Bureau to develop the concept of operations, assessing the associated roles, responsibilities and resource implications, for discussion at the sixty-fifth session.

36. The Committee noted that the secretariat and the Bureau had already taken steps to involve scientists from other States Members of the United Nations in supporting the secretariat in conducting ongoing evaluations.

37. The Committee also noted that the secretariat continued to liaise with other relevant organizations, in particular IAEA, the International Labour Organization, and the World Health Organization for matters directly related to its programme of work. Through the Inter-Agency Committee on Radiation Safety the Committee liaised with the same organizations as well as with other relevant international

[10] *Sources, Effects and Risks of Ionizing Radiation: United Nations Scientific Committee on the Effects of Atomic Radiation 2016 Report to the General Assembly* (United Nations publication, Sales No. E.17.IX.1).

[11] Available at http://www.unscear.org. The work of UNSCEAR is linked to achieving Sustainable Development Goals 3, 14 and 15.

[12] See General Assembly resolution 70/1.

governmental and non-governmental organizations collectively to avoid duplication of efforts to the extent possible.[11]

## D. Future programme of work

38. The Committee discussed plans for two new projects, one on second primary cancers after radiotherapy and another on epidemiological studies of radiation and cancer. It also considered two new proposals for future work, namely a revision of the 2013 UNSCEAR report on the levels and effects of radiation exposure due to the 2011 Fukushima accident and a re-evaluation of exposure to natural sources of radiation. Having considered the current work programme, the capacity of both the Committee and its secretariat, and the foreseeable voluntary contributions to the general trust fund established by the Executive Director of UNEP, the Committee requested the Bureau to foster the development and implementation of project plans on second primary cancers after radiotherapy and on epidemiological studies of radiation and cancer in line with the guiding principles of UNSCEAR and the processes to ensure quality evaluations. The Committee further requested that a project plan be developed for consideration at the sixty-fifth session to update the Committee's 2013 report on the levels and effects of exposure due to the Fukushima accident. The proposal to re-evaluate human exposures to natural radiation sources was received positively. However, the Committee decided to postpone project initiation until its report on lung cancer from exposure to radon and to penetrating radiation was completed, and more extensive data on human exposures from natural sources in different parts of the world became available.

## E. Administrative issues

39. The Committee noted that its current scientific secretary had, in January 2017, tendered his resignation with effect from November 2017. The Committee also noted that the general trust fund was currently depleted, which would result in the departure of two additional secretariat staff in June and November 2017, respectively. Consequently, the capacity of the secretariat would be severely limited until a suitable replacement for the scientific secretary could be found. The Committee expressed its highest appreciation of the work of its outgoing secretary, noting its concern that, apparently, UNEP had not yet initiated the procedure of selecting a suitable replacement. The Committee also noted that the roles and responsibilities of the secretariat of UNSCEAR, of UNEP and of staff at United Nations Headquarters, the United Nations Office at Nairobi, and the United Nations Office at Vienna needed clarification.

40. The Committee recognized that, because of the need to maintain the intensity of its work — particularly its work to develop exposure databases and to improve the dissemination of its findings to the public — regular pledges to make voluntary contributions to the general trust fund would be pivotal. In particular, considering the encouragement expressed by the General Assembly in its resolution 71/89, the Committee recognized that the secretariat would require additional professional personnel support to meet the implementation goals set forth, i.e. to further enhance the dissemination of the findings of the Committee. The Committee suggested that the General Assembly urge Member States to consider making regular pledges of

[11] The Inter-Agency Committee on Radiation Safety (IACRS) was formed in 1990 to facilitate collaboration between international organizations in matters of radiation safety. It provides a forum for the exchange of information between member agencies and organizations on their activities with a view to harmonizing to the extent possible their plans and activities related to radiation safety and avoid duplication of radiation safety standards and recommendations. As and when appropriate, IACRS considers proposals for and facilitates the review and revision of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. IACRS functions without prejudice to the roles and responsibilities of the member organizations and agencies (see http://www.iacrs-rp.org/).

voluntary contributions to the general trust fund for those purposes or to make contributions in kind.

41. The Committee agreed to hold its sixty-fifth session in Vienna from 23 to 27 April 2018.

# Chapter III

## Scientific report

42. Two scientific annexes provide the rationale for the findings set out below.

### A. Principles and criteria for ensuring the quality of the Committee's reviews of epidemiological studies of radiation exposure

43. Evidence from epidemiological studies of radiation exposure forms an important part of the scientific evaluation of radiation effects regularly conducted and reported by the Committee. Epidemiological studies are evaluated by the Committee to assess the health risks of radiation exposure. Methods to synthesize evidence have evolved considerably during recent decades, particularly in evidence-based medicine and health risk assessment. The current preferred methods of evidence synthesis are systematic reviews, meta-analyses and pooled analyses, which are regarded as the state-of-the-art scientific standards for pooling research data and are deemed superior to traditional narrative reviews.

44. The Committee discussed principles and criteria for ensuring the quality of its reviews of epidemiological studies of radiation exposure that take into account these scientific developments. The specific nature and scientific contents of such studies do not allow for a mechanistic application of generic quality assurance criteria. Therefore, the Committee has developed an approach to assess the quality of such studies and to synthesize the findings from many studies into its evaluations of radiation effects. The Committee's approach provides for increased methodological rigour, which is expected to further enhance the degree of coherence, transparency and objectivity in its evaluations.

45. A focus on the quality of the various studies and the assessment of their strengths and limitations are long-standing features of the Committee's work. The Committee will systematically apply the principles and approach described in this annex for its evaluations of epidemiological studies of radiation exposure, wherever applicable. Ideally, similar principles and approaches should be applied to the selection and inclusion of literature from other sciences, such as radiobiology, radiation dosimetry and radiation physics, into future reviews and evaluations of the Committee.

### B. Epidemiological studies of cancer risk due to low-dose-rate radiation from environmental sources

46. In recent years, the Committee has been evaluating epidemiological studies analysing cancer risk on the basis of individual doses due to exposure at low dose rates from environmental sources. The overall results of those studies do not provide evidence of a risk of cancer per unit dose higher than that derived from studies of high radiation doses. There is considerable uncertainty in the estimates owing to both limited statistical power and limitations in other aspects such as residual confounding and inaccuracies in exposure assessment. Hence, the bounds of uncertainty do not rule out a lower risk per unit dose than that observed in studies of higher doses.

47. Environmental radiation exposure at low dose rates typically results in low and moderate doses, and therefore potential excess cancer risks are expected to be small. The estimation of such small incremental risks of cancer from protracted exposures could easily be affected by confounding due to other cancer risk factors. This may contribute to the differences between study results, because the existence of confounders and their association with radiation exposure can vary. An analysis accounting for the effects of confounders also sets requirements for sample size in a study. Precise estimates of health effects and their frequencies need sufficient follow-up, case ascertainment through high-quality cancer registry systems and accurate

information on risk factors other than radiation exposure. This emphasizes the need for prospective long-term studies with high-quality dosimetry, as well as comprehensive and accurate outcome data and information on cancer risk factors other than radiation exposure.

48. The Committee recognizes that studies of low-dose-rate exposure from environmental sources can potentially contribute to a better understanding of the risks of radiation-induced cancer. Direct evidence from such studies would be important because the general population is exposed to radiation primarily at low dose rates. However, improvements would be needed to overcome the key limitations of the studies, including low statistical power, dosimetric uncertainties and imperfections in control of confounding.

49. At its sixty-fourth session, the Committee discussed the relevance of the dose and the dose rate effectiveness factor, a radiation protection concept, in the context of scientific evaluations of epidemiological studies of cancer risk from low-dose-rate exposure.[14] It concluded that the dose response relationships depend on a large number of factors such that the scientific evidence regarding a possible reduction in the radiation-induced effects per unit dose at low doses and low dose rates relative to acute exposures with moderate or high doses cannot be expressed by a single value. The Committee is evaluating separately the influence of dose and dose rate by cancer type, and continues to review the developments in epidemiological, biological and statistical analyses that contribute to improved inference and estimation of low-dose and low-dose-rate health effects.

[14] Introduced in *Sources and Effects of Ionizing Radiation. United Nations Scientific Committee on the Effects of Atomic Radiation 1993 Report to the General Assembly with Scientific Annexes*, annex F (United Nations publication, Sales No. E.94.IX.2).

## Appendix I

### Members of national delegations attending the sixty-second to sixty-fourth sessions of the United Nations Scientific Committee on the Effects of Atomic Radiation

| | |
|---|---|
| Argentina | A. J. González (Representative), A. Canoba, P. Carretto, M. di Giorgio, M. G. Ermacora |
| Australia | G. Hirth (Representative), M. Grzechnik, C.-M. Larsson (Representative), C. Lawrence |
| Belarus | A. Stazharau (Representative), A. Nikalayenka, A. Rozhko, V. Ternov, N. Vlasova |
| Belgium | H. Vanmarcke (Representative), S. Baatout, H. Bosmans, H. Engels, F. Jamar, L. Mullenders, H. Slaper, P. Smeesters, A. Wambersie, P. Willems |
| Brazil | L. Vasconcellos de Sá (Representative), J. G. Hunt (Representative), D. de Souza Santos |
| Canada | P. Thompson (Representative), J. Chen, P. Demers, C. Lavoie, E. Waller, R. Wilkins |
| China | Z. Pan (Representative), L. Dong, T. Fang, D. Huang, Y. Li, X. Lin, J. Liu, L. Liu, S. Liu, J. Mao, S. Pan, G. Song, Q. Sun, F. Yang, H. Yang, X. Wu, P. Zhou |
| Egypt | W. M. Badawy (Representative), T. Morsi |
| Finland | S. Salomaa (Representative), A. Auvinen, E. Salminen |
| France | J.-R. Jourdain (Representative), E. Ansoborlo, J.-M. Bordy, I. Clairand, I. Dublineau-Naud, L. Lebaron-Jacobs (Representative), K. Leuraud, F. Ménétrier, A. Rannou, M. Tirmarche |
| Germany | P. Jacob (Representative), S. Baechler, A. Böttger, A. A. Friedl, K. Gehrcke, T. Jung, J. Kopp, R. Michel, W.-U. Müller, W. Rühm, W. Weiss, H. Zeeb |
| India | K. S. Pradeepkumar (Representative), R. A. Badwe (Representative), B. Das, A. Ghosh |
| Indonesia | E. Hiswara (Representative), Z. Alatas (Representative) |
| Japan | M. Akashi (Representative), K. Akahane, S. Akiba, N. Ban, H. Fujita, R. Kanda, I. Kawaguchi, K. Kodama, M. Kowatari, M. Nakano, S. Saigusa, K. Sakai, H. Yasuda, Y. Yonekura (Representative) |
| Mexico | J. Aguirre Gómez (Representative) |
| Pakistan | R. A. Khan (Representative), Z. A. Baig (Representative), M. Ali (Representative) |
| Peru | A. Lachos Dávila (Representative), B. M. García Gutiérrez |
| Poland | M. Waligórski (Representative), L. Dobrzyński, M. Janiak, M. Kruszewski |
| Republic of Korea | B. S. Lee (Representative), K.-W. Cho (Representative), M. Baek, M.-S. Jeong, J. K. Kang, J.-I. Kim, K. P. Kim, S. H. Kim, D.-K. Keum, J. K. Lee, J. E. Lee, S. W. Seo, K. M. Seong |

| | |
|---|---|
| Russian Federation | A. Akleyev (Representative), R. Alexakhin, T. Azizova, S. Geraskin, D. Ilyasov, V. Ivanov, L. Karpikova, A. Koterov, A. Kryshev, S. Mikheenko, A. Rachkov, S. Romanov, A. Samoylov, A. Sazhin, S. Shinkarev, V. Uyba, V. Usoltsev |
| Slovakia | L. Auxtová (Representative), M. Berčíková, A. Ďurecová, V. Jurina, K. Petrová, L. Tomášek |
| Spain | M. J. Muñoz González (Representative), M. T. Macías Domínguez, J. C. Mora Cañadas, B. Robles Atienza, E. Vañó Carruana |
| Sudan | R.O.A. Alfaki (Representative), N. A. Ahmed (Representative), I. I. Suliman |
| Sweden | I. Lund (Representative), L. Hubbard, E. Forssell Aronsson, P. Hofvander, J. Lillhök, A. Wojcik |
| Ukraine | D. Bazyka (Representative) |
| United Kingdom of Great Britain and Northern Ireland | S. Bouffler (Representative), A. Bexon, J. Harrison (Representative), R. Wakeford, W. Zhang |
| United States of America | E. V. Holahan Jr. (Representative), A. Ansari, L. R. Anspaugh, J. D. Boice Jr., W. Bolch, H. Grogan, N. H. Harley, B. A. Napier, D. Pawel, R. J. Preston (Representative), G. E. Woloschak |





## Appendix II

### Scientific staff and consultants cooperating with the United Nations Scientific Committee on the Effects of Atomic Radiation in the preparation of its scientific report for 2017

A. Auvinen

H. Zeeb

**Secretariat of the United Nations Scientific Committee on the Effects of Atomic Radiation**

M. J. Crick

F. Shannoun

K. Tani (seconded)